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THE USE OF MICROSOFT EXCEL TO SIMULATE THE CHARGING CAPACITOR (C) THROUGH A RESISTANCE (R), AND CALCULATING THE APPROPRIATE VALUE OF T (RC) OF 8051 MICROCONTROLLER RESET CIRCUIT

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ABSTRACT

On this occasion, the author would like to discuss the use of Microsoft Excel to simulate the charging of the capacitor (C) through a resistance (R) of the 8051 microcontroller reset circuits [1]. The author would also shows the equation (rule of thumb) to calculate the appropriate value of τ (RC) used to form the 8051 microprocessor reset circuit and using the table and the graph obtained from Microsoft Excel to opt the proper RC value.

KEYWORDS: 8051 Microprocessor Reset Circuits, TTL (Transistor Transistor Logic) Voltage Range

INTRODUCTION

Due to a lot of student that forwarded inquiries at my microprocessor / microcontroller class and electronics enthusiasts on the blog [3] asked technique or method to calculate the values of the resistor and capacitor of microcontroller 8051 reset circuits has inspired the authors to carry out this research (literature Study). To master the method of determining the value of these two components, an understanding of the working principle of charging and discharging the capacitor through a resistance is highly required (DC voltage source). It will not only help the students of how to calculate the capacitor and resistor values of microcontroller reset circuits, but will also provide a basis for them to understand other subjects such as Electrical, Analog Electronics, Digital Electronics, Microprocessor / microcontroller, Computers and other electronics studies. The authors hope this paper will contribute to science, especially in helping the teacher or lecturer to teach and facilitate students to comprehend the working principle of charging a capacitor through a resistance of 8051 microprocessor reset circuit.

Main

The figure below shows the block diagram of the reset circuits of the microprocessor 8051 system.

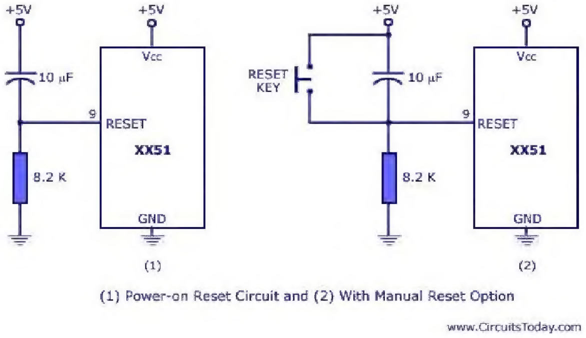

Figure 1: The Types of Reset Circuits of Microcontroller 8051[2]

A 8051 Microprocessor will be in a reset state if pin 9 (RESET pin) see figure 1 above gets a 5 V DC voltage (Active High) for at least 2 MCs (MC-Machine Cycle)[4][15][19].

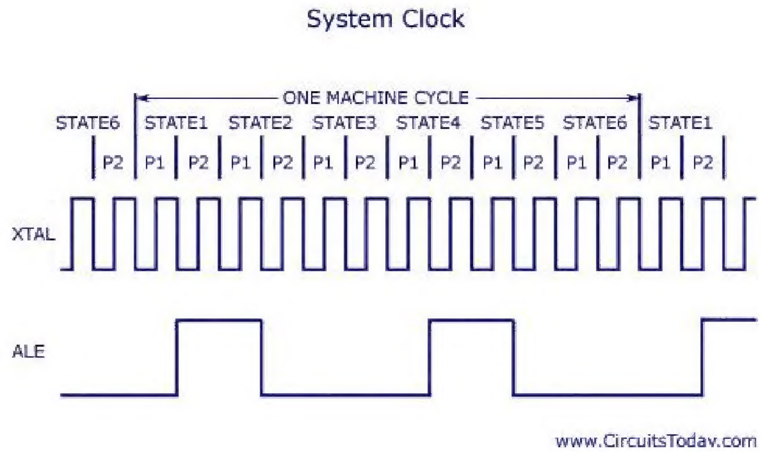

Figure 2: MC-Machine Cycle [4]

Figure 2 above shows a machine cycle, it can be seen from the figure that a machine cycle consists of six states (State 1-State 6) and each state consists of two pulses (P1 and P2), each pulse (P) is a full cycle of the oscillator (clock)[4]. In other words, a machine cycle consists of 12 pulses of oscillator (clock); a single machine cycle is the minimum time required to perform an instruction of 8051 microcontroller[15][16], several instructions require more than one machine cycle (2 and 4) to complete them[16][17]. In general an instruction of 8051 microcontroller requires only one machine cycle (12 clock pulses), but some instructions require 2 Machine Cycles and two instructions take 4 Machine Cycles (MUL AB and DIV AB) [17] to finish their work [16][17]. From the above discussion we can see that to put 8051 microprocessor in a valid reset state we must connect pin 9 of the 8051 microprocessor to a 5 Volt DC voltage source for at least 24 oscillator cycles (P) or 2 Machine Cycles, 2 X 12 oscillator cycles [4][13]. The period of the oscillator cycle (P) depends on the type of crystal used in the oscillator circuits. A 12 MHz crystal is generally used, but for application in associated with serial data communications a 11.0592 MHz crystal should be used[4][15]. In this study we will use the 12 MHz crystal oscillator; you can do the same calculation for a 11.0592 MHz crystal oscillator as for 12 MHz crystal oscillator.

For crystal oscillator with a frequency of 12 MHz (12×10^6 Hz) there will be 12 million ($12 \text{ X } 10^6$) pulses per second. Thus the period (T) of one pulse is $\frac{1}{12} \text{ X } 10^{-6}$ s (seconds), therefore the period of one machine cycle is 10^{-6} seconds (1 μ sec); $12 \text{ X } \frac{1}{12} \text{ X } 10^{-6}$seconds. As it has been mentioned before in order to enter the valid reset state, the 8051 microcontroller pin 9 (reset) has to be connected to 5 volts (Vcc) for > 2 μ sec (2 Machine Cycles)[4] . This term of time > 2 μ sec (2 Machine Cycles) will be used by the author as one of the requirements for calculating the appropriate value of R and C of 8051 microcontroller reset circuits.

There are two types of reset of the 8051 microprocessor, known as power on reset and manual reset see figure 1[2][15]. Power on reset occurs when microprocessor gets either a DC voltage of 5 Volt from a battery or other source of DC voltage; voltage source with a regulator that can maintain a 5 V (DC) output voltage such as the LM7805 [9]. While the manual reset, reset will occur when the reset button is pressed [4].

To analyze the 8051 microcontroller reset circuit in Figure 1 above, we can redraw it as shown in figure 3 below with assumption that input impedance of the 8051 microcontroller is infinite; 8051 Microcontroller does not load the reset circuits.

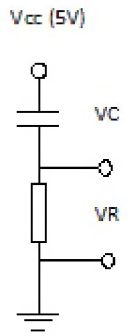

Figure 3: Microprocessor 8051 Reset Circuits

From Electricity and basic electronics course we know that the equation for charging the capacitor through a resistor can be written as equation 1 below [7][8][18].

$$Vc = V(1 - e^{-t/RC}) \tag{1}$$

And from KVL (Kircoff Voltage Law) we know that

$$V = VC + VR \tag{2}$$

and

$$VC = V - VR \tag{3}$$

If we apply the distributive law of multiplication over subtraction on equation 1 we will get

$$VC = V - Ve^{-t/RC} \tag{4}$$

And from equations 3 and 4 we can see that the voltage across the resistor (R) is

$$VR = Ve^{-t/RC} \tag{5}$$

We will use equation 1 and equation 5 in Microsoft Excel to depict the graph of VC and VR (Voltage on C and R consecutively) versus time (seconds) as shown in Figure 4 below (τ = RC = 1 second, and Vcc = 5V).

τ = RC with unit of second (s) is the time taken by the capacitor (C) to charge and achieve a voltage of 63% of the source voltage (3.2 V) and for the resistor (R) to drop from Vcc to 37% (1.8 V) of the source voltage (Vcc) if the voltage source is 5 V[18].

When 5 Volt DC voltage source has not been connected to Vcc of 8051microcontroller system, Vcc voltage will be at 0 Volts so does the voltage on the capacitor and resistor (VR + VC = Vcc), the capacitor will have a total discharge [7]. However when 5 Volt DC voltage source connected to the 8051 microcontroller system, pin 40 (Vcc) will get 5 Volt

DC voltage and pin 20 (GND) will get Ground (0 Volt) from the power supply, the voltage on the capacitor will initially be at 0 volts and the voltage of the resistor will be at 5 volts (Vcc = VR + VC) and so does the voltage on pin 9 (reset) will get the same voltage of 5 volts; cause the system microcontroller will enter the reset state. According to equation 1 the voltage on the capacitor will increase slowly from 0 Volts (the speed of capacitor charging will depend on RC value) over time toward 5 volts and reverse voltage development will occur across the resistor as equation 5 shows; it will go down or drop to 0 volts from 5 Volts which will cause the microcontroller to enters the normal state (not in the reset state) when a threshold voltage low (1.2 V) is reached, see figure 4 below.

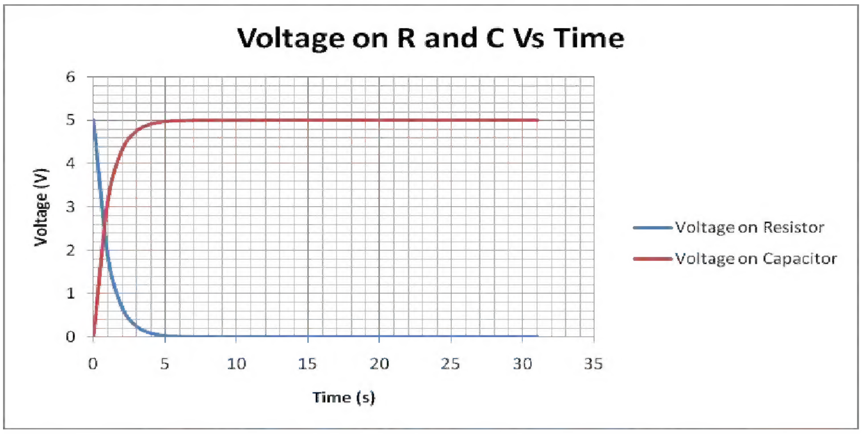

Figure 4: The Graph of Voltage Across C and R Vs Time (τ (R X C)=1 Second)

When the manual reset key, see figure 1 is pressed, a voltage of 5 Volts (DC) will be at the RST pin (pin 9) of the 8051 microcontroller and will be back soon (within a period of 0.1 seconds) to a voltage of 0 volts when the key is released[6][14].

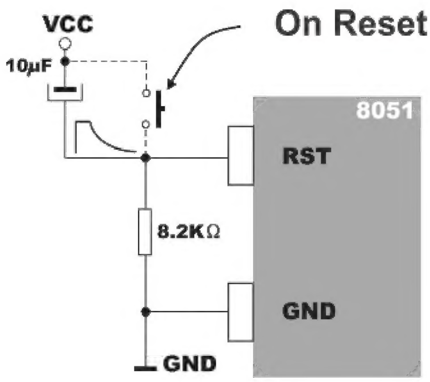

Figure 5: Manual Reset of 8051 Microcontroller [14]

When entering a reset state (manual reset) the contents of the internal RAM will not be interrupted, the contents of the PC (program counter) is removed and filled with 00h, bank 0 register is selected as the default bank register, (SP) Stack Pointer will be initialized to 07h, and all ports (port 0-port 3) will be filled with 0FFh [4]. In practice the 8051 voltage logic is in the TTL (transistor transistor logic) voltage range[15], threshold voltage of 8051 microcontroller is between 1.1 V to 1.3 V[7];input voltage below that voltage is considered to be a logic 0 voltage, and voltage above that voltage is considered as a logic 1 voltage. Thus the microcontroller will be in the reset state when the voltage on pin 9 (reset) is still at about 1.2 V (average of 1.1 V and 1.3 V), the voltage on the capacitor C is 3.8 V.

The author will use this threshold voltage of 1.2 V across R (3.8 V voltages on capacitor C) as the key point in calculating the appropriate value of the capacitor and resistor of the 8051 Microcontroller 8051 reset circuit.

We can use equation 5 to determine the value of R and C in accordance with the requirements (the valid reset conditions to occur) as mentioned above; oscillator and power supply are in stable condition, and the reset pin should be maintained at 5 Volts for 24 clock cycles (2 µ sec) period of time. Oscillator will be stable after 1 ms and the power supply will be stable after 10 ms [20]; after switching the power supply voltage on.

From equation 5 we get that

$$\frac{VR}{V} = e^{-t/RC} \tag{6}$$

And,

$$Ln(\frac{VR}{V}) = Ln(e^{-t/RC}) \tag{7}$$

Then, we can write that,

$$Ln(\frac{VR}{V}) = \frac{-t}{RC} \tag{8}$$

From equation 8 we can determine the value of the corresponding RC. $Ln(\frac{VR}{V})$ will result in a negative value.

If we put VR = 1.2 V and V=5V, then $Ln(\frac{VR}{V})$ will be -1,427 thus equation 8 can be rearranged into

$$1{,}427 = \frac{t}{RC} \tag{9}$$

As discussed earlier, when the power supply is turned on reset circuit will maintain the state of the reset pin high (1) for some time; duration of the reset pin in a high state is determined by the value of R and C of the reset circuit.

To guarantee the valid reset to occur [20], the reset pin must be maintained in a high state (5 Volts) for a long enough time to ensure oscillator in a start-up state (1ms), the power supply to be stable (10 ms) plus a 2-Machine Cycle (2µ sec) then from equation 9 to ensure a valid reset state to occur we choose t≥ 100 m S then we can opt the equation for determining the appropriate value of the RC as follows [7],

$$RC \geq 100ms \tag{10}$$

The combination of the value of R = 10 K Ω, and C = 10µF will give RC = 100 ms. Reset circuits of R = 8K2Ω and C = 10 µF is widely used in various applications of microcontroller 8051 will give RC = 82 ms.

The graph below shows the simulation results of the voltage across the resistor for various values of τ (RC); 1ms, 10 ms, 20 ms, 40 ms, 80ms, and 160 ms.

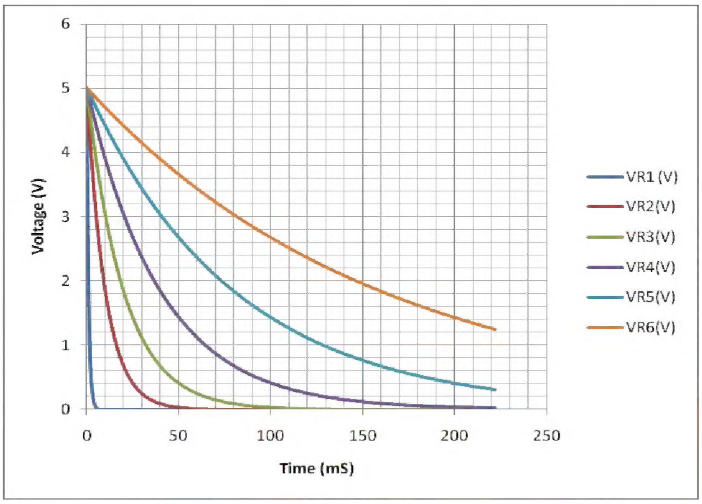

Figure 6: Graph of Voltage across R vs. Time for Some RC Values (1 ms, 10 ms, 20 ms, 40 ms, 80 ms, and 160 ms)[10][11]

Table 1 below is used to depict the graphs in Figure 6. The formula for VR1, VR2, VR3, VR4, VR5, and VR6 are the following consecutively. $VR1 = 5e^{-t/1ms}$, $VR2 = 5e^{-t/10ms}$, $VR3 = 5e^{-t/20ms}$, $VR4 = 5e^{-t/40ms}$, $VR5 = 5e^{-t/80ms}$, and $VR6 = 5e^{-t/160ms}$

Table 1: Voltage across R VS Time for Various Values of RC (1ms, 10 ms, 20 ms, 40 ms, 80 ms, Dan 160 ms)[10][11]

t (ms)	VR1 (V)	VR2(V)	VR3(V)	VR4(V)	VR5(V)	VR6(V)
0	5	5	5	5	5	5
1	1,839397	4,524187	4,756147	4,87655	4,937889	4,968847
2	0,676676	4,093654	4,524187	4,756147	4,87655	4,937889
3	0,248935	3,704091	4,30354	4,638717	4,815972	4,907123
4	0,091578	3,3516	4,093654	4,524187	4,756147	4,87655
5	0,03369	3,032653	3,894004	4,412485	4,697065	4,846166
6	0,012394	2,744058	3,704091	4,30354	4,638717	4,815972
7	0,004559	2,482927	3,52344	4,197285	4,581094	4,785966
8	0,001677	2,246645	3,3516	4,093654	4,524187	4,756147
9	0,000617	2,032848	3,188141	3,992581	4,467987	4,726514
10	0,000227	1,839397	3,032653	3,894004	4,412485	4,697065
11	8,35E-05	1,664355	2,884749	3,797861	4,357672	4,6678
12	3,07E-05	1,505971	2,744058	3,704091	4,30354	4,638717
13	1,13E-05	1,362659	2,610229	3,612637	4,25008	4,609816
14	4,16E-06	1,232985	2,482927	3,52344	4,197285	4,581094
15	1,53E-06	1,115651	2,361833	3,436446	4,145146	4,552552
16	5,63E-07	1,009483	2,246645	3,3516	4,093654	4,524187
17	2,07E-07	0,913418	2,137075	3,268849	4,042802	4,495999
18	7,61E-08	0,826494	2,032848	3,188141	3,992581	4,467987
19	2,8E-08	0,747843	1,933705	3,109425	3,942984	4,440149
20	1,03E-08	0,676676	1,839397	3,032653	3,894004	4,412485
21	3,79E-09	0,612282	1,749689	2,957777	3,845632	4,384992
22	1,39E-09	0,554016	1,664355	2,884749	3,797861	4,357672
23	5,13E-10	0,501294	1,583184	2,813524	3,750683	4,330521
24	1,89E-10	0,45359	1,505971	2,744058	3,704091	4,30354
25	6,94E-11	0,410425	1,432524	2,676307	3,658078	4,276727
26	2,55E-11	0,371368	1,362659	2,610229	3,612637	4,25008
27	9,4E-12	0,336028	1,296201	2,545782	3,56776	4,2236

Table 1: Contd.,

28	3,46E-12	0,30405	1,232985	2,482927	3,52344	4,197285
29	1,27E-12	0,275116	1,172851	2,421623	3,479672	4,171134
30	4,68E-13	0,248935	1,115651	2,361833	3,436446	4,145146
31	1,72E-13	0,225246	1,06124	2,303519	3,393758	4,119319
32	6,33E-14	0,203811	1,009483	2,246645	3,3516	4,093654
33	2,33E-14	0,184416	0,96025	2,191175	3,309966	4,068148
34	8,57E-15	0,166866	0,913418	2,137075	3,268849	4,042802
35	3,15E-15	0,150987	0,86887	2,08431	3,228243	4,017613
36	1,16E-15	0,136619	0,826494	2,032848	3,188141	3,992581
37	4,27E-16	0,123618	0,786186	1,982657	3,148537	3,967705
38	1,57E-16	0,111854	0,747843	1,933705	3,109425	3,942984
39	5,77E-17	0,10121	0,71137	1,885962	3,070799	3,918418
40	2,12E-17	0,091578	0,676676	1,839397	3,032653	3,894004
41	7,81E-18	0,082863	0,643675	1,793982	2,994981	3,869742
42	2,87E-18	0,074978	0,612282	1,749689	2,957777	3,845632
43	1,06E-18	0,067843	0,582421	1,706489	2,921035	3,821672
44	3,89E-19	0,061387	0,554016	1,664355	2,884749	3,797861
45	1,43E-19	0,055545	0,526996	1,623262	2,848914	3,774198
46	5,27E-20	0,050259	0,501294	1,583184	2,813524	3,750683
47	1,94E-20	0,045476	0,476846	1,544095	2,778574	3,727314
48	7,13E-21	0,041149	0,45359	1,505971	2,744058	3,704091
49	2,62E-21	0,037233	0,431468	1,468789	2,709971	3,681013
50	9,64E-22	0,03369	0,410425	1,432524	2,676307	3,658078
51	3,55E-22	0,030484	0,390408	1,397155	2,643062	3,635286
52	1,31E-22	0,027583	0,371368	1,362659	2,610229	3,612637
53	4,8E-23	0,024958	0,353256	1,329015	2,577804	3,590128
54	1,77E-23	0,022583	0,336028	1,296201	2,545782	3,56776
55	6,5E-24	0,020434	0,319639	1,264198	2,514158	3,545531
56	2,39E-24	0,018489	0,30405	1,232985	2,482927	3,52344
57	8,79E-25	0,01673	0,289222	1,202542	2,452083	3,501488
58	3,24E-25	0,015138	0,275116	1,172851	2,421623	3,479672
59	1,19E-25	0,013697	0,261699	1,143894	2,391541	3,457991
60	4,38E-26	0,012394	0,248935	1,115651	2,361833	3,436446
61	1,61E-26	0,011214	0,236795	1,088105	2,332494	3,415036
62	5,93E-27	0,010147	0,225246	1,06124	2,303519	3,393758
63	2,18E-27	0,009182	0,214261	1,035038	2,274904	3,372613
64	8,02E-28	0,008308	0,203811	1,009483	2,246645	3,3516
65	2,95E-28	0,007517	0,193871	0,984558	2,218737	3,330718
66	1,09E-28	0,006802	0,184416	0,96025	2,191175	3,309966
67	3,99E-29	0,006155	0,175422	0,936541	2,163956	3,289343
68	1,47E-29	0,005569	0,166866	0,913418	2,137075	3,268849
69	5,4E-30	0,005039	0,158728	0,890865	2,110527	3,248482
70	1,99E-30	0,004559	0,150987	0,86887	2,08431	3,228243
71	7,31E-31	0,004126	0,143623	0,847417	2,058418	3,208129
72	2,69E-31	0,003733	0,136619	0,826494	2,032848	3,188141
73	9,9E-32	0,003378	0,129956	0,806088	2,007596	3,168277
74	3,64E-32	0,003056	0,123618	0,786186	1,982657	3,148537
75	1,34E-32	0,002765	0,117589	0,766775	1,958028	3,12892
76	4,93E-33	0,002502	0,111854	0,747843	1,933705	3,109425
77	1,81E-33	0,002264	0,106399	0,729379	1,909684	3,090052
78	6,67E-34	0,002049	0,10121	0,71137	1,885962	3,070799
79	2,45E-34	0,001854	0,096274	0,693807	1,862534	3,051667
80	9,02E-35	0,001677	0,091578	0,676676	1,839397	3,032653
81	3,32E-35	0,001518	0,087112	0,659969	1,816548	3,013758
82	1,22E-35	0,001373	0,082863	0,643675	1,793982	2,994981

Table 1: Contd.,

83	4,49E-36	0,001243	0,078822	0,627782	1,771697	2,976321
84	1,65E-36	0,001124	0,074978	0,612282	1,749689	2,957777
85	6,08E-37	0,001017	0,071321	0,597165	1,727954	2,939348
86	2,24E-37	0,000921	0,067843	0,582421	1,706489	2,921035
87	8,23E-38	0,000833	0,064534	0,568041	1,68529	2,902835
88	3,03E-38	0,000754	0,061387	0,554016	1,664355	2,884749
89	1,11E-38	0,000682	0,058393	0,540337	1,64368	2,866776
90	4,1E-39	0,000617	0,055545	0,526996	1,623262	2,848914
91	1,51E-39	0,000558	0,052836	0,513985	1,603098	2,831164
92	5,54E-40	0,000505	0,050259	0,501294	1,583184	2,813524
93	2,04E-40	0,000457	0,047808	0,488917	1,563517	2,795995
94	7,5E-41	0,000414	0,045476	0,476846	1,544095	2,778574
95	2,76E-41	0,000374	0,043258	0,465072	1,524914	2,761262
96	1,02E-41	0,000339	0,041149	0,45359	1,505971	2,744058
97	3,74E-42	0,000306	0,039142	0,442391	1,487264	2,726961
98	1,37E-42	0,000277	0,037233	0,431468	1,468789	2,709971
99	5,06E-43	0,000251	0,035417	0,420815	1,450543	2,693086
100	1,86E-43	0,000227	0,03369	0,410425	1,432524	2,676307
101	6,84E-44	0,000205	0,032047	0,400292	1,414729	2,659632
102	2,52E-44	0,000186	0,030484	0,390408	1,397155	2,643062
103	9,26E-45	0,000168	0,028997	0,380769	1,379799	2,626594
104	3,41E-45	0,000152	0,027583	0,371368	1,362659	2,610229
105	1,25E-45	0,000138	0,026238	0,362199	1,345732	2,593966
106	4,61E-46	0,000125	0,024958	0,353256	1,329015	2,577804
107	1,7E-46	0,000113	0,023741	0,344534	1,312506	2,561743
108	6,24E-47	0,000102	0,022583	0,336028	1,296201	2,545782
109	2,3E-47	9,23E-05	0,021482	0,327731	1,2801	2,529921
110	8,44E-48	8,35E-05	0,020434	0,319639	1,264198	2,514158
111	3,11E-48	7,56E-05	0,019437	0,311747	1,248494	2,498493
112	1,14E-48	6,84E-05	0,018489	0,30405	1,232985	2,482927
113	4,2E-49	6,19E-05	0,017588	0,296543	1,217668	2,467457
114	1,55E-49	5,6E-05	0,01673	0,289222	1,202542	2,452083
115	5,69E-50	5,07E-05	0,015914	0,282081	1,187604	2,436805
116	2,09E-50	4,58E-05	0,015138	0,275116	1,172851	2,421623
117	7,7E-51	4,15E-05	0,014399	0,268323	1,158282	2,406535
118	2,83E-51	3,75E-05	0,013697	0,261699	1,143894	2,391541
119	1,04E-51	3,4E-05	0,013029	0,255237	1,129684	2,37664
120	3,83E-52	3,07E-05	0,012394	0,248935	1,115651	2,361833
121	1,41E-52	2,78E-05	0,011789	0,242789	1,101792	2,347117
122	5,19E-53	2,52E-05	0,011214	0,236795	1,088105	2,332494
123	1,91E-53	2,28E-05	0,010667	0,230948	1,074589	2,317961
124	7,02E-54	2,06E-05	0,010147	0,225246	1,06124	2,303519
125	2,58E-54	1,86E-05	0,009652	0,219685	1,048057	2,289167
126	9,5E-55	1,69E-05	0,009182	0,214261	1,035038	2,274904
127	3,5E-55	1,53E-05	0,008734	0,208971	1,02218	2,26073
128	1,29E-55	1,38E-05	0,008308	0,203811	1,009483	2,246645
129	4,73E-56	1,25E-05	0,007903	0,198779	0,996943	2,232647
130	1,74E-56	1,13E-05	0,007517	0,193871	0,984558	2,218737
131	6,4E-57	1,02E-05	0,007151	0,189084	0,972328	2,204913
132	2,36E-57	9,25E-06	0,006802	0,184416	0,96025	2,191175
133	8,67E-58	8,37E-06	0,00647	0,179863	0,948321	2,177523
134	3,19E-58	7,58E-06	0,006155	0,175422	0,936541	2,163956
135	1,17E-58	6,85E-06	0,005854	0,171091	0,924907	2,150473
136	4,31E-59	6,2E-06	0,005569	0,166866	0,913418	2,137075
137	1,59E-59	5,61E-06	0,005297	0,162746	0,902071	2,12376

Table 1: Contd.,

138	5,84E-60	5,08E-06	0,005039	0,158728	0,890865	2,110527
139	2,15E-60	4,59E-06	0,004793	0,154809	0,879799	2,097378
140	7,9E-61	4,16E-06	0,004559	0,150987	0,86887	2,08431
141	2,91E-61	3,76E-06	0,004337	0,147259	0,858076	2,071324
142	1,07E-61	3,4E-06	0,004126	0,143623	0,847417	2,058418
143	3,93E-62	3,08E-06	0,003924	0,140077	0,83689	2,045593
144	1,45E-62	2,79E-06	0,003733	0,136619	0,826494	2,032848
145	5,32E-63	2,52E-06	0,003551	0,133245	0,816228	2,020183
146	1,96E-63	2,28E-06	0,003378	0,129956	0,806088	2,007596
147	7,21E-64	2,06E-06	0,003213	0,126747	0,796075	1,995088
148	2,65E-64	1,87E-06	0,003056	0,123618	0,786186	1,982657
149	9,75E-65	1,69E-06	0,002907	0,120566	0,77642	1,970304
150	3,59E-65	1,53E-06	0,002765	0,117589	0,766775	1,958028
151	1,32E-65	1,38E-06	0,002631	0,114685	0,75725	1,945829
152	4,86E-66	1,25E-06	0,002502	0,111854	0,747843	1,933705
153	1,79E-66	1,13E-06	0,00238	0,109092	0,738553	1,921657
154	6,57E-67	1,03E-06	0,002264	0,106399	0,729379	1,909684
155	2,42E-67	9,28E-07	0,002154	0,103772	0,720318	1,897786
156	8,89E-68	8,39E-07	0,002049	0,10121	0,71137	1,885962
157	3,27E-68	7,6E-07	0,001949	0,098711	0,702534	1,874211
158	1,2E-68	6,87E-07	0,001854	0,096274	0,693807	1,862534
159	4,43E-69	6,22E-07	0,001763	0,093897	0,685188	1,850929
160	1,63E-69	5,63E-07	0,001677	0,091578	0,676676	1,839397
161	5,99E-70	5,09E-07	0,001596	0,089317	0,668271	1,827937
162	2,2E-70	4,61E-07	0,001518	0,087112	0,659969	1,816548
163	8,11E-71	4,17E-07	0,001444	0,084961	0,651771	1,80523
164	2,98E-71	3,77E-07	0,001373	0,082863	0,643675	1,793982
165	1,1E-71	3,41E-07	0,001306	0,080817	0,635679	1,782805
166	4,04E-72	3,09E-07	0,001243	0,078822	0,627782	1,771697
167	1,49E-72	2,79E-07	0,001182	0,076876	0,619984	1,760659
168	5,46E-73	2,53E-07	0,001124	0,074978	0,612282	1,749689
169	2,01E-73	2,29E-07	0,00107	0,073127	0,604676	1,738787
170	7,39E-74	2,07E-07	0,001017	0,071321	0,597165	1,727954
171	2,72E-74	1,87E-07	0,000968	0,06956	0,589747	1,717188
172	1E-74	1,69E-07	0,000921	0,067843	0,582421	1,706489
173	3,68E-75	1,53E-07	0,000876	0,066168	0,575186	1,695856
174	1,35E-75	1,39E-07	0,000833	0,064534	0,568041	1,68529
175	4,98E-76	1,26E-07	0,000792	0,062941	0,560984	1,67479
176	1,83E-76	1,14E-07	0,000754	0,061387	0,554016	1,664355
177	6,74E-77	1,03E-07	0,000717	0,059871	0,547134	1,653986
178	2,48E-77	9,3E-08	0,000682	0,058393	0,540337	1,64368
179	9,13E-78	8,42E-08	0,000649	0,056951	0,533625	1,633439
180	3,36E-78	7,61E-08	0,000617	0,055545	0,526996	1,623262
181	1,24E-78	6,89E-08	0,000587	0,054174	0,52045	1,613149
182	4,54E-79	6,23E-08	0,000558	0,052836	0,513985	1,603098
183	1,67E-79	5,64E-08	0,000531	0,051531	0,5076	1,59311
184	6,15E-80	5,1E-08	0,000505	0,050259	0,501294	1,583184
185	2,26E-80	4,62E-08	0,000481	0,049018	0,495067	1,57332
186	8,32E-81	4,18E-08	0,000457	0,047808	0,488917	1,563517
187	3,06E-81	3,78E-08	0,000435	0,046628	0,482844	1,553776
188	1,13E-81	3,42E-08	0,000414	0,045476	0,476846	1,544095
189	4,14E-82	3,1E-08	0,000393	0,044354	0,470922	1,534474
190	1,52E-82	2,8E-08	0,000374	0,043258	0,465072	1,524914
191	5,61E-83	2,53E-08	0,000356	0,04219	0,459295	1,515413
192	2,06E-83	2,29E-08	0,000339	0,041149	0,45359	1,505971

Table 1: Contd.,

193	7,59E-84	2,08E-08	0,000322	0,040133	0,447955	1,496588
194	2,79E-84	1,88E-08	0,000306	0,039142	0,442391	1,487264
195	1,03E-84	1,7E-08	0,000291	0,038175	0,436895	1,477997
196	3,78E-85	1,54E-08	0,000277	0,037233	0,431468	1,468789
197	1,39E-85	1,39E-08	0,000264	0,036314	0,426108	1,459637
198	5,11E-86	1,26E-08	0,000251	0,035417	0,420815	1,450543
199	1,88E-86	1,14E-08	0,000239	0,034543	0,415588	1,441505
200	6,92E-87	1,03E-08	0,000227	0,03369	0,410425	1,432524
201	2,55E-87	9,33E-09	0,000216	0,032858	0,405327	1,423599
202	9,36E-88	8,44E-09	0,000205	0,032047	0,400292	1,414729
203	3,45E-88	7,63E-09	0,000195	0,031255	0,395319	1,405914
204	1,27E-88	6,91E-09	0,000186	0,030484	0,390408	1,397155
205	4,66E-89	6,25E-09	0,000177	0,029731	0,385559	1,38845
206	1,72E-89	5,66E-09	0,000168	0,028997	0,380769	1,379799
207	6,31E-90	5,12E-09	0,00016	0,028281	0,376039	1,371202
208	2,32E-90	4,63E-09	0,000152	0,027583	0,371368	1,362659
209	8,54E-91	4,19E-09	0,000145	0,026902	0,366755	1,354169
210	3,14E-91	3,79E-09	0,000138	0,026238	0,362199	1,345732
211	1,16E-91	3,43E-09	0,000131	0,02559	0,357699	1,337347
212	4,25E-92	3,1E-09	0,000125	0,024958	0,353256	1,329015
213	1,56E-92	2,81E-09	0,000119	0,024342	0,348868	1,320734
214	5,75E-93	2,54E-09	0,000113	0,023741	0,344534	1,312506
215	2,12E-93	2,3E-09	0,000107	0,023155	0,340254	1,304328
216	7,79E-94	2,08E-09	0,000102	0,022583	0,336028	1,296201
217	2,86E-94	1,88E-09	9,7E-05	0,022025	0,331853	1,288125
218	1,05E-94	1,7E-09	9,23E-05	0,021482	0,327731	1,2801
219	3,88E-95	1,54E-09	8,78E-05	0,020951	0,32366	1,272124
220	1,43E-95	1,39E-09	8,35E-05	0,020434	0,319639	1,264198
221	5,25E-96	1,26E-09	7,94E-05	0,019929	0,315669	1,256321
222	1,93E-96	1,14E-09	7,56E-05	0,019437	0,311747	1,248494

From the discussion, table 1 and figure 6 above several points can be drawn as conclusions, such as,

- The value of RC is made in such a way as to make sure to obtain the valid duration of reset (reset pin is maintained in a high state for 2 machine cycles or 24 clock cycles (2 μ seconds), waiting for the oscillator to stabilize in1 ms and for the power supply to be stable in 10 ms)
- RC value of 1 ms is too short, and will lead to failure to achieve a valid reset state; voltage VR = 1.2 is reached (reset occurs) in just 1.427 ms
- For RC = 80 ms reset (VR = 1.2 V) will be reached in about 115 ms
- For RC = 160 ms reset (VR = 1.2 V) will be accomplished in about 222 ms; too long
- Equation 10 is good enough to determine the value of RC, it can guarantee the achievement of a valid reset state of 8051 microcontroller

CONCLUSIONS

This paper is expected to contribute to science, particularly in the areas of Microprocessor, Computer, Analog Electronics, and Digital Electronics. And it can be used as a media for teaching and learning process that will make it easier for student to comprehend the subject and the teacher or lecturer to carry out the teaching process better.

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